AMD

RUSTEC'2020

AMD ROCm™ and Radeon Instinct™: A Platform for High Performance Computing and Machine Intelligence

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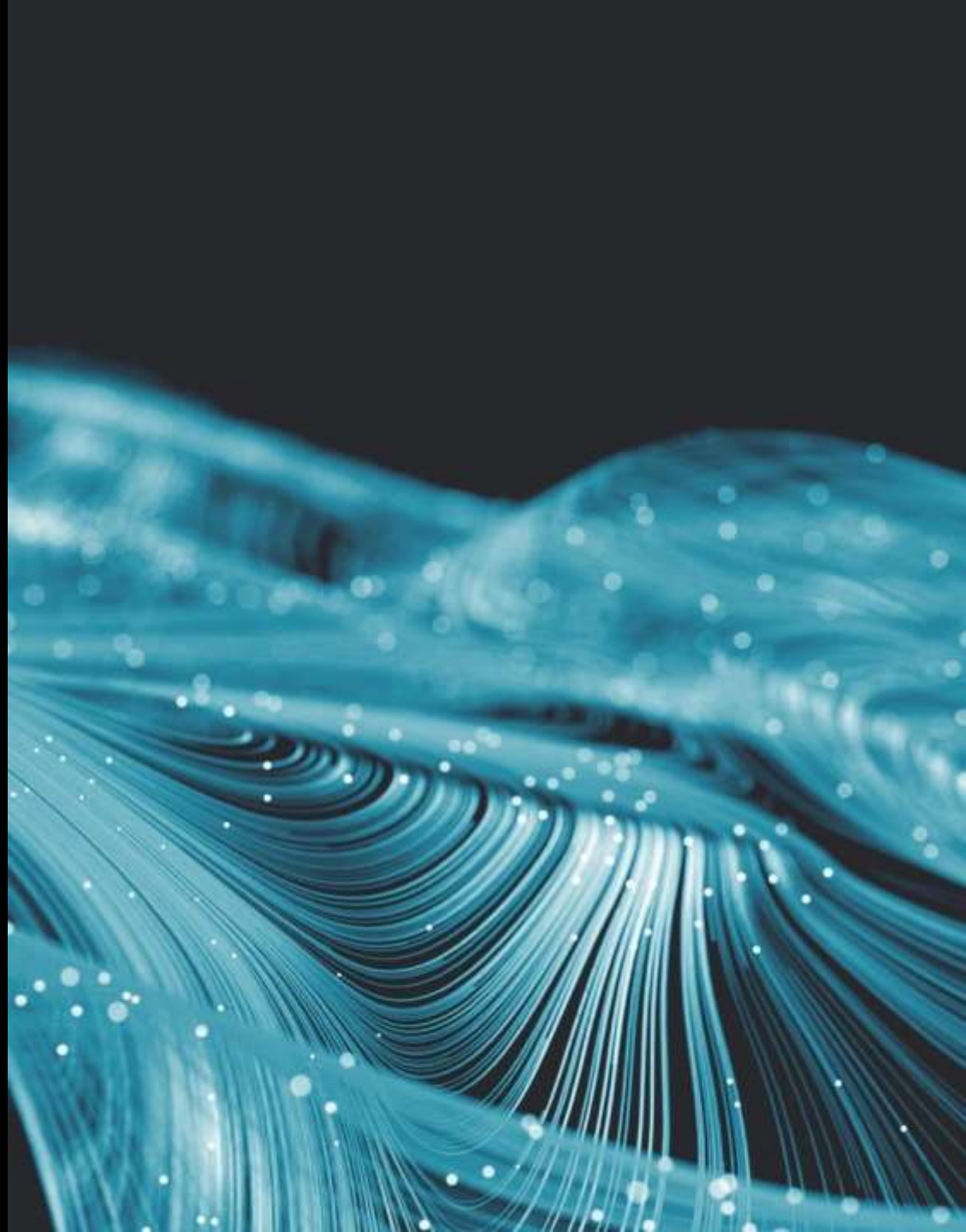
AMD PUBLIC



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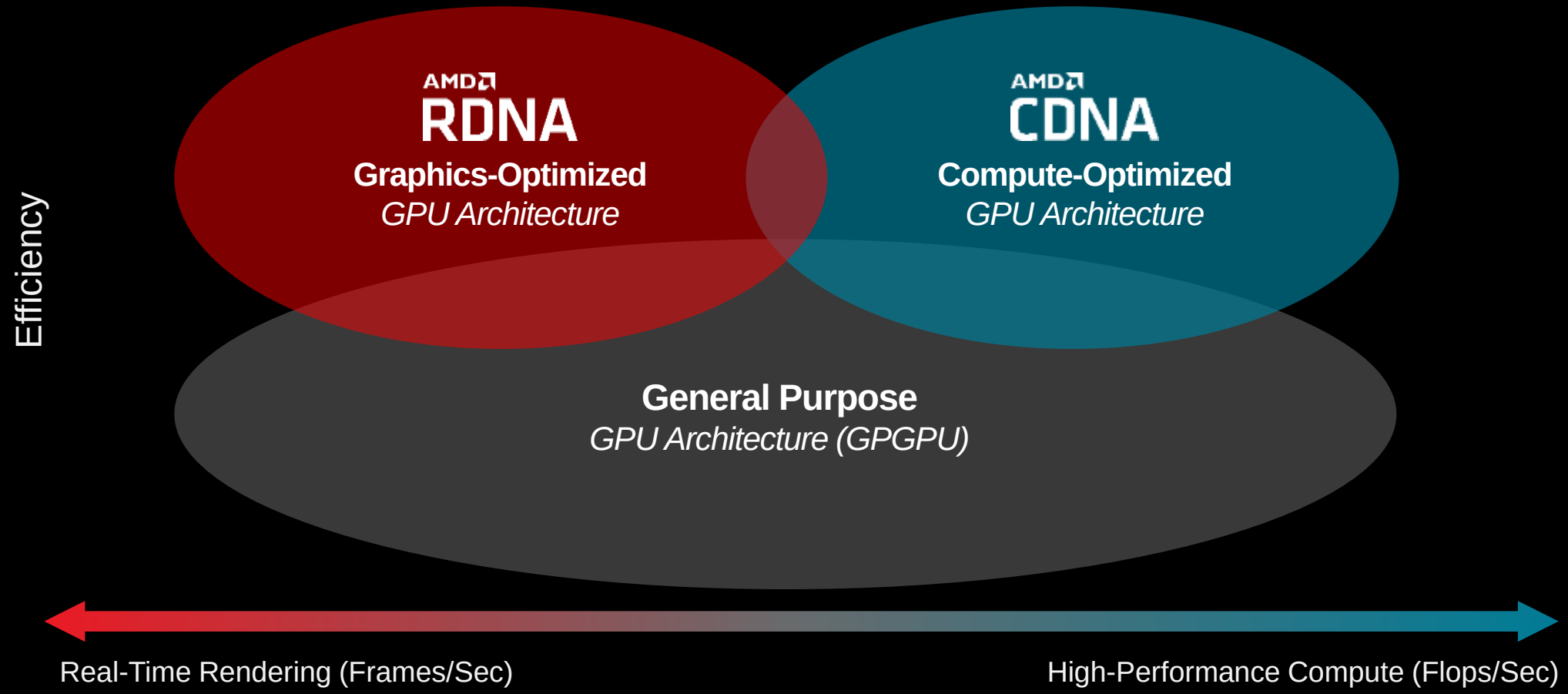
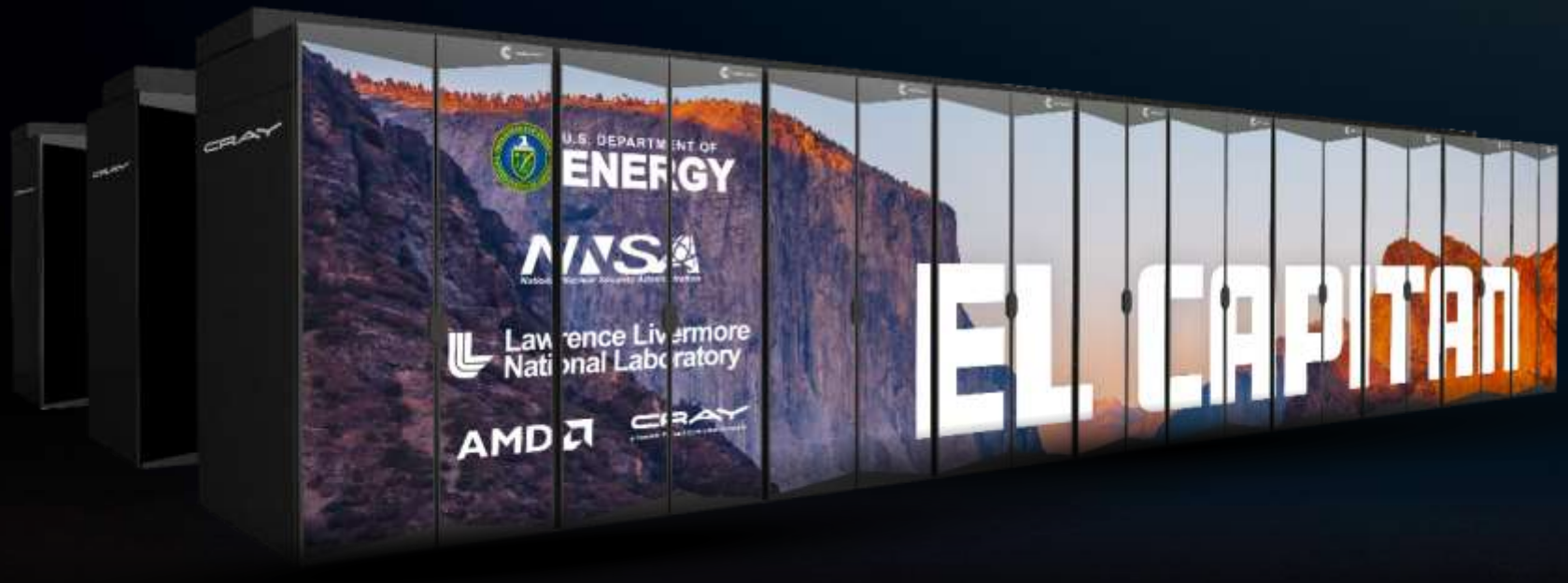
Differentiated Strategy

Optimal Efficiency Through Domain-Specific Optimizations





AMD EPYC™ CPUs & Radeon Instinct™ GPUs Leading The Exascale Era

>2 ExaFLOPS Expected	Expected to be More Powerful than Today's 200 Fastest Supercomputers Combined	AMD Shipments in 2022

Source: https://www.top500.org/lists/top500/2020/06/

AMD CDNA Architecture

Compute DNA for the Data Center

Performance
Accelerate ML/HPC with Compute/Tensor OPS

Efficiency
Help Reduce TCO with High Perf-per-Watt

Features
Enhance Enterprise RAS, Security and Virtualization

Scalability
Scale Performance with AMD Infinity Architecture

What is ROCm™?

An Open Software Platform for GPU-accelerated Computing

AMD ROCm

Frameworks and Applications
TensorFlow, PyTorch, Caffe2

Libraries
MIOpen, roc* libraries

Programming models
HIP, C/C++, Python

Intermediate runtimes/compilers
LLVM based Clang, HCC

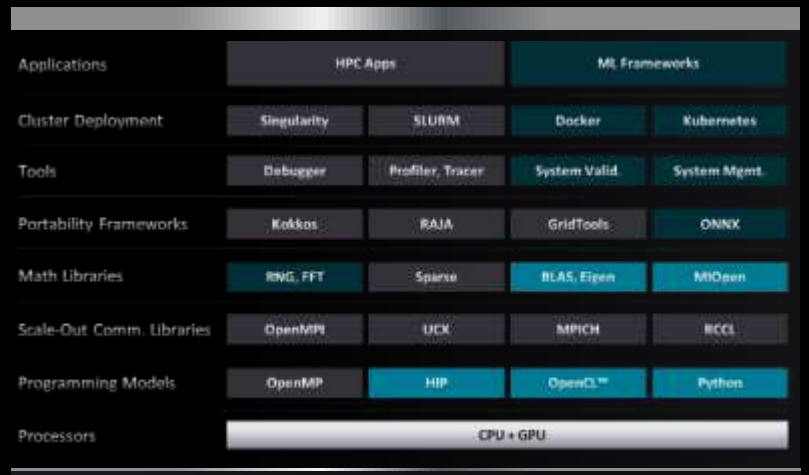
Runtimes
ROCm

Programmer and system tools
-debug
-profile

Data Center Software Evolution

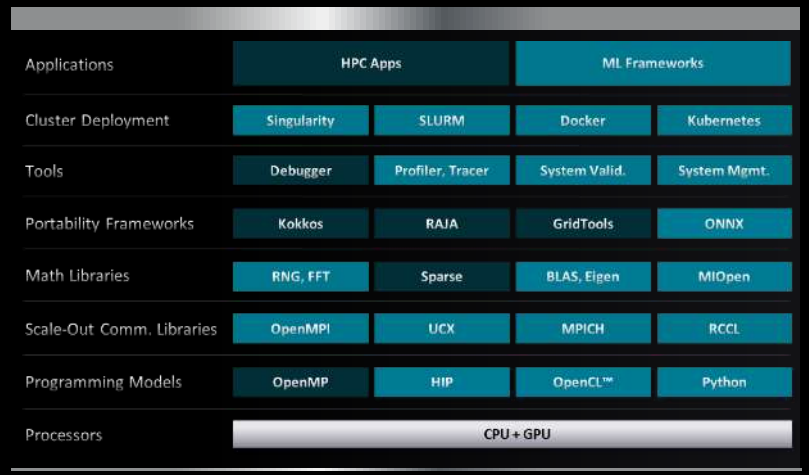
Steady Progress and Growing Ecosystem Support

AMD ROCm



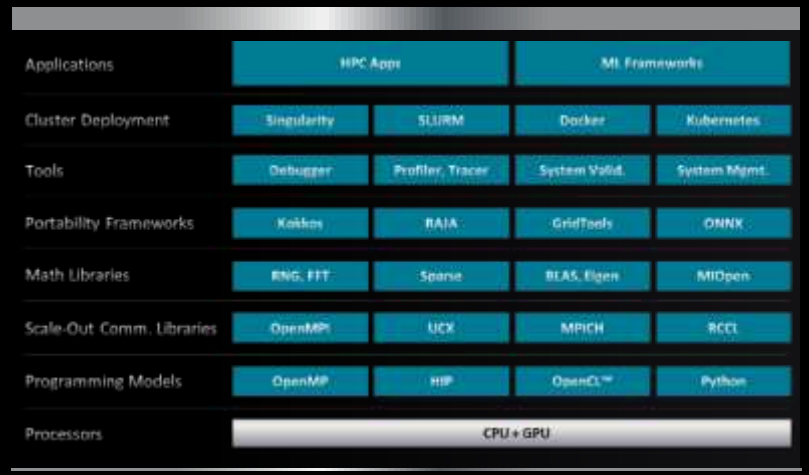
2018: AMD ROCm™ 2.0 Platform

Building the Foundation



2019: AMD ROCm™ 3.0 Platform

Focused on Machine Learning



2020 Plan: AMD ROCm™ 4.0 Platform

Complete Exascale Solution for ML/HPC

Future | Beta/Early | Production

Machine Intelligence

Natural Language Processing

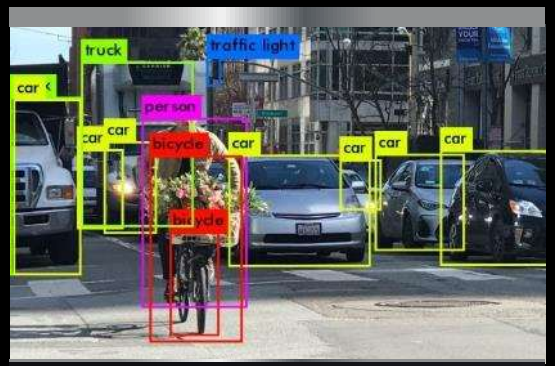


Image Recognition

Recommendation Engines

Industrial Automation

Revolutionizing Applications in Every Field

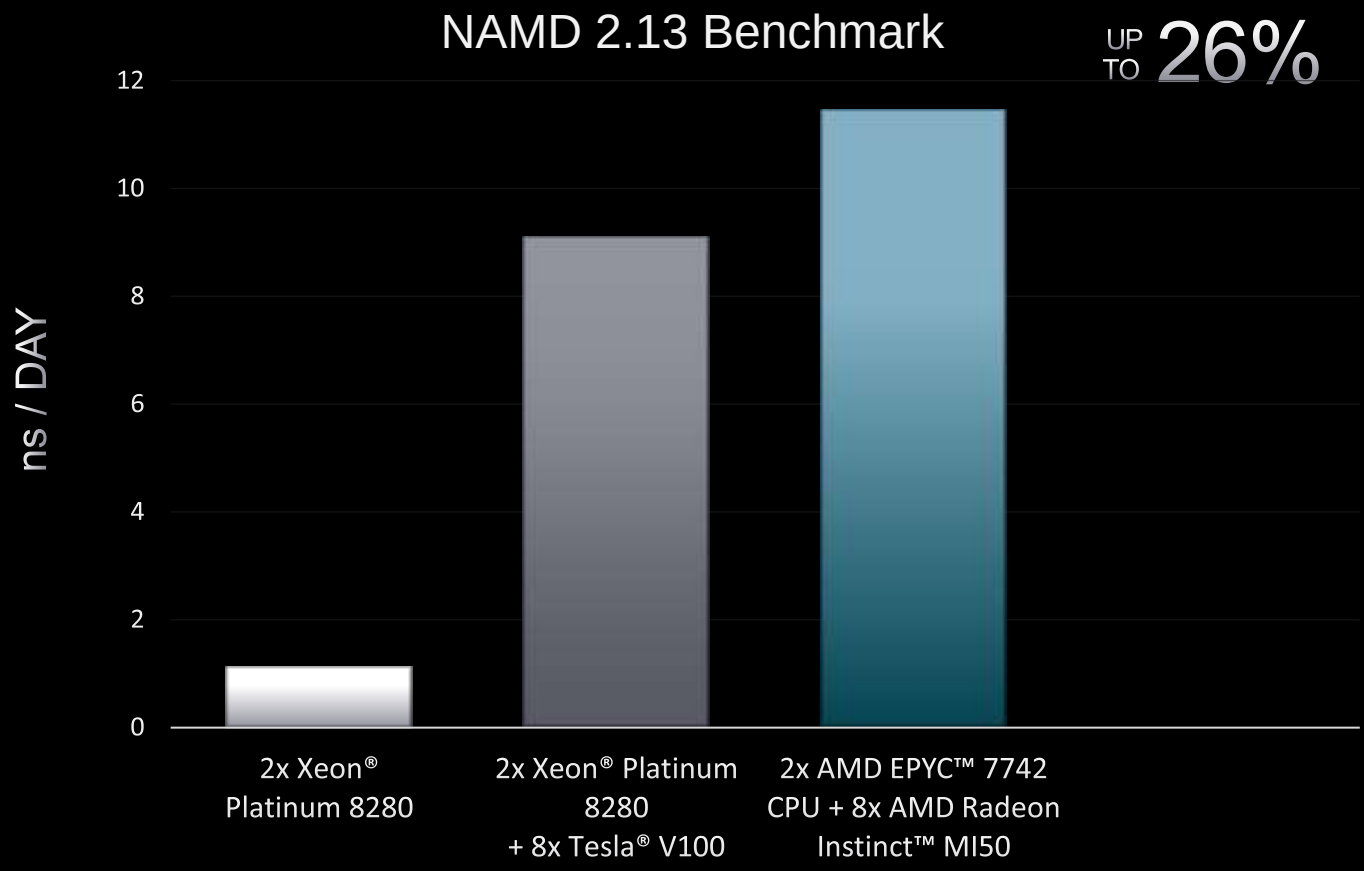
Exponentially Growing Demands for Performance

AMD Champions Open Source Solutions

AMD CPU + GPU + SW Advantages

Driving High-performance Computing Leadership

- Fully Integrated CPU and GPU Systems and Unified Tools
- Infinity Architecture for Bandwidth and Coherency
- Open Source Software Optimized for Performance



Testing Conducted by AMD performance lab as of 11-10-2019 using NAMD 2.13, STMV 1M Atom benchmark. Best-in-class based on industry-standard pin-based (LGA) X86 processors. Results may vary. (RIV-20)

HIP: Multi-Platform Capability for TCO Optimization

Easy to Deploy Porting Capability

CUDA-based application

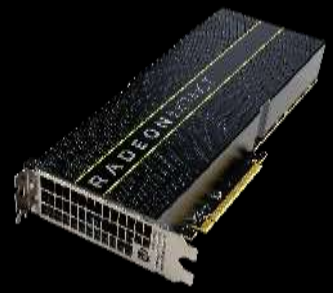
"HIPify"

Virtually Automatic Conversion

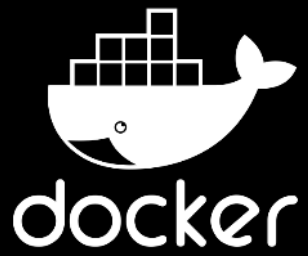
Portable HIP C++

Developer maintains HIP port

Resulting C++ code runs on NVIDIA or AMD GPUs



Fast-Growing ROCm™ Ecosystem



Containers

Sylabs Singularity

Data Center Workload Manager

Container Orchestration

Performance Profiling & System Tracer via PAPI

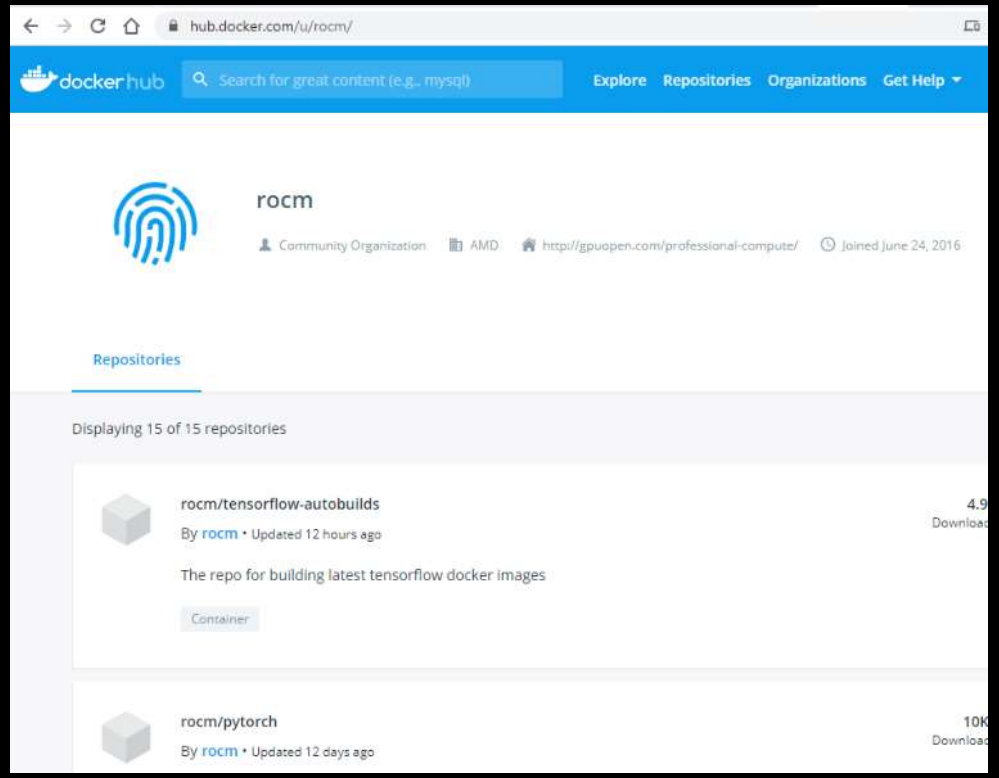
Eclipse C/C++ Development Tooling Based on ROC-GDB

Upstream ML Frameworks

Exascale Tools, Programming Models and Applications

Docker®

- Set permissions and add user to docker group
  - groups # identify the groups member
  - sudo usermod -a -G docker $LOGNAME
- ROCm™ Docker Hub
  - https://hub.docker.com/u/rocm/
- Run Docker Image
- docker run -it --network=host --device=/dev/kfd --device=/dev/dri --group-add video --cap-add=SYS_PTRACE --security-opt seccomp=unconfined -v /home/user:/home/user rocm/dev-ubuntu-18.04 bash
- Show running image
  - docker image ls
- Save container to your own image
  - Run docker commit on another terminal window
  - docker commit <container id> <my_docker_image>



Machine Learning Models

Deployable Today with Continuous Optimizations

Image Classification	Object Detection	Neural Machine Translation	Reinforcement Learning	Recommender Systems	Generative Models
• ResNet50/101 • ResNet152 • Inception3/4 • VGG16/19 • ShuffleNet • MobileNet • DenseNet • AlexNet • SqueezeNet • GoogleNet • ResNext101	• Faster-RCNN-ResNet50 • Mask-RCNN-ResNet50 • SSD-Resnet50	• GNMT: LSTMs • Translate: LSTMs • BERT: Transformer • GPT-2: Transformer	• Atari • Cart_Pole • VizDoom	• DLRM	• DCGAN • Fast Neural Style Transfer

AMD GPU Compilers:

C/C++

HIP (hip-clang)

- HIP (Heterogeneous Interface for Portability) is an interface that provides similar functionality to CUDA API
- Compiles HIP code and emits AMDGCN into binary
- hipcc -> hip-clang -> amdgcn
- Compiles to NVIDIA GPU with NVCC & its tool chain
- All the x86 pieces are dealt with in the same way

AOMP (AMD OpenMP Compiler)

- Compiles C/C++ code with OpenMP “target” pragmas
- Links with libomptarget to produce a binary that can offload work to the GPU

OpenCL™

- Khronos Industry Standard accelerator language

The GCN ISA is free and open!
https://developer.amd.com/resources/developer-guides-manuals/

AMD GPU Compilers: Fortran

OpenMP

- Support OpenMP 4.5+ target offload from FORTRAN with two open source options:
- F18 based on LLVM
- gfortran

HIP

- Offload kernels to GPU using Fortran 2003 C-binding
- hipfort project (in plan) to ease the wrap of GPU libraries

Frontier

- See Frontier spec sheet for what is expected to be supported: https://www.olcf.ornl.gov/wp-content/uploads/2019/05/frontier_specsheet.pdf

GPU Compilers Under Development: OpenACC

Mentor Graphics

- Has built GCC backend supporting the AMDGCN ISA

GCC

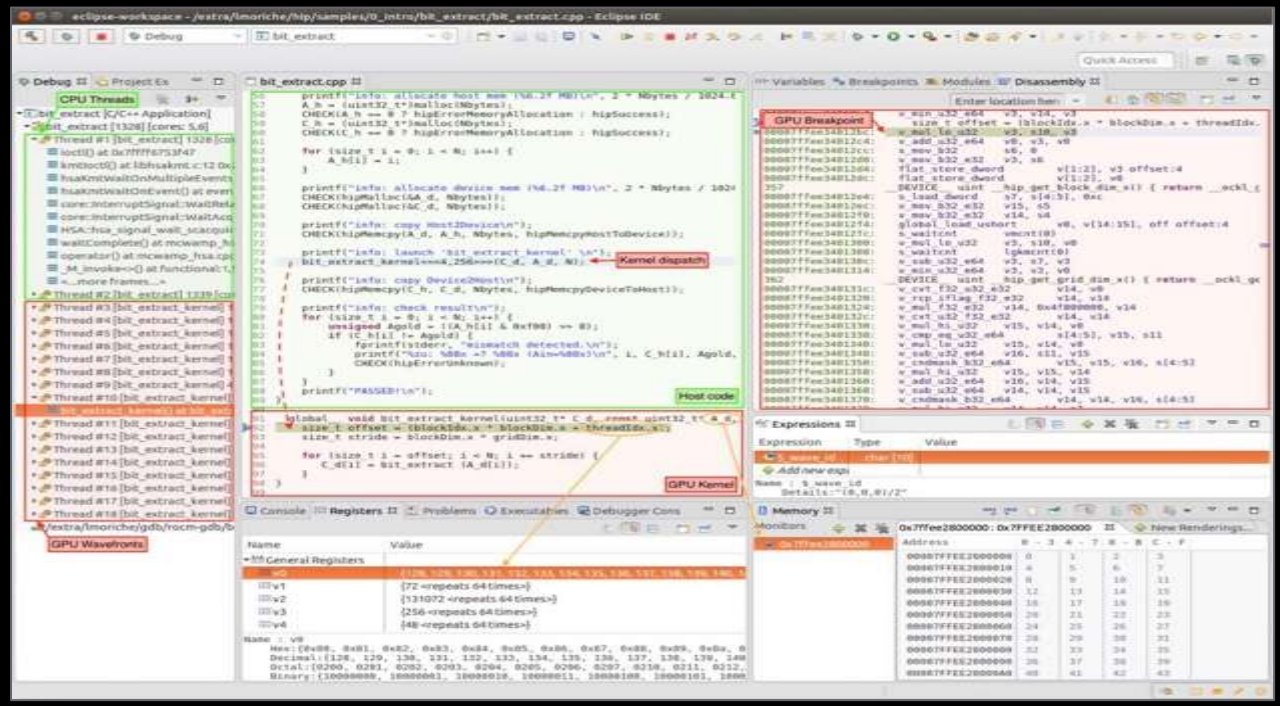
- OpenACC v2.6 is implemented in gcc and gfortran
- Mentor released updated compiler May 2020
- Optimizations and bug fixes ongoing – target Nov 2020 release

LLVM

- The Clacc project implements OpenACC in clang and can convert to OpenMP https://csmd.ornl.gov/project/clacc

Unified CPU & GPU Debugger

Easily Integrated with Industry Standard Tools



ROC-gdb
(gdb with GPU support)

RogueWave SOFTWARE
TotalView®

Linux Kernel
(ptrace)

ROC-dbgapi
(GPU Low Level Debug API Library)

GPU Kernel Driver

POLYTECHNIQUE MONTRÉAL

Released Q2-2020

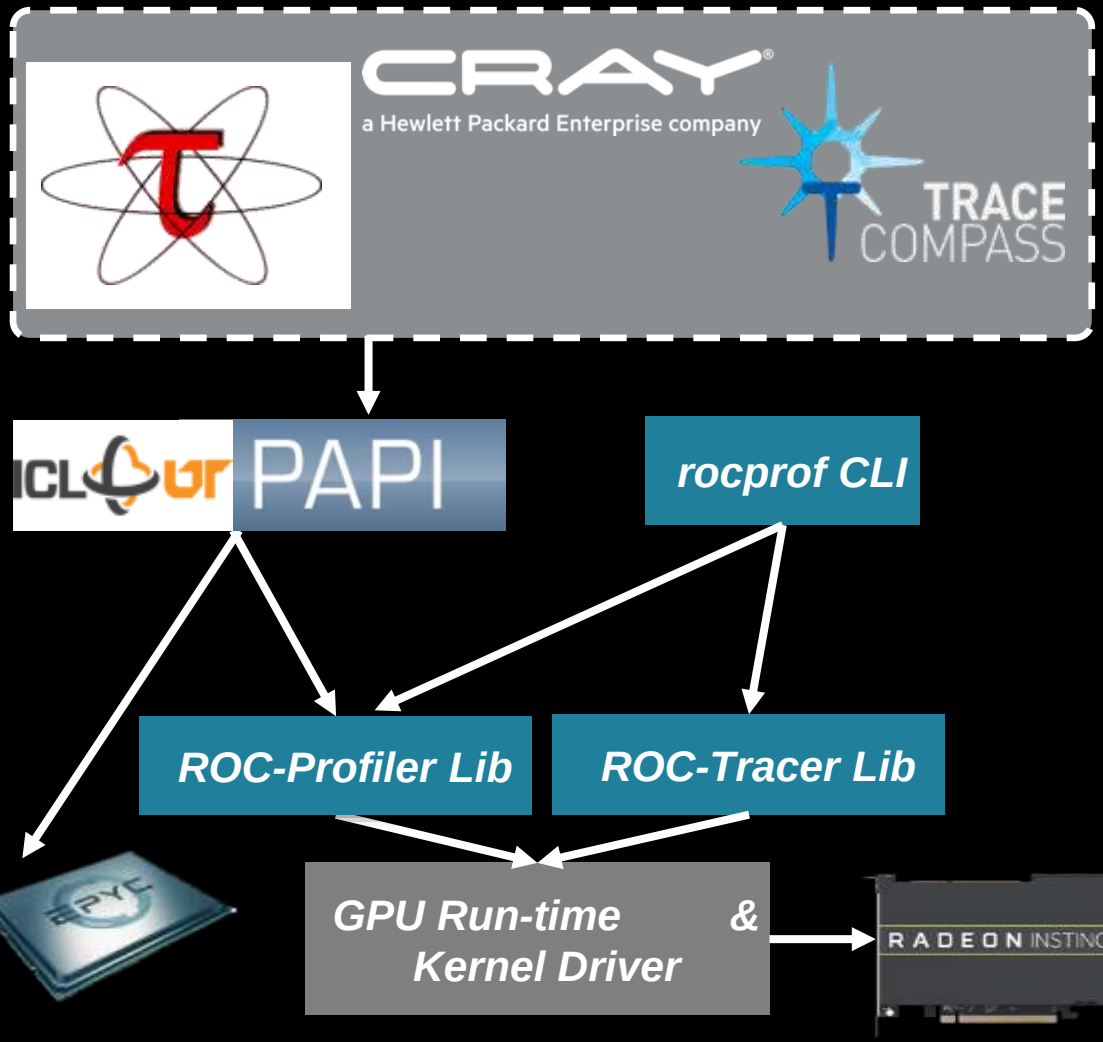
ROCgdb

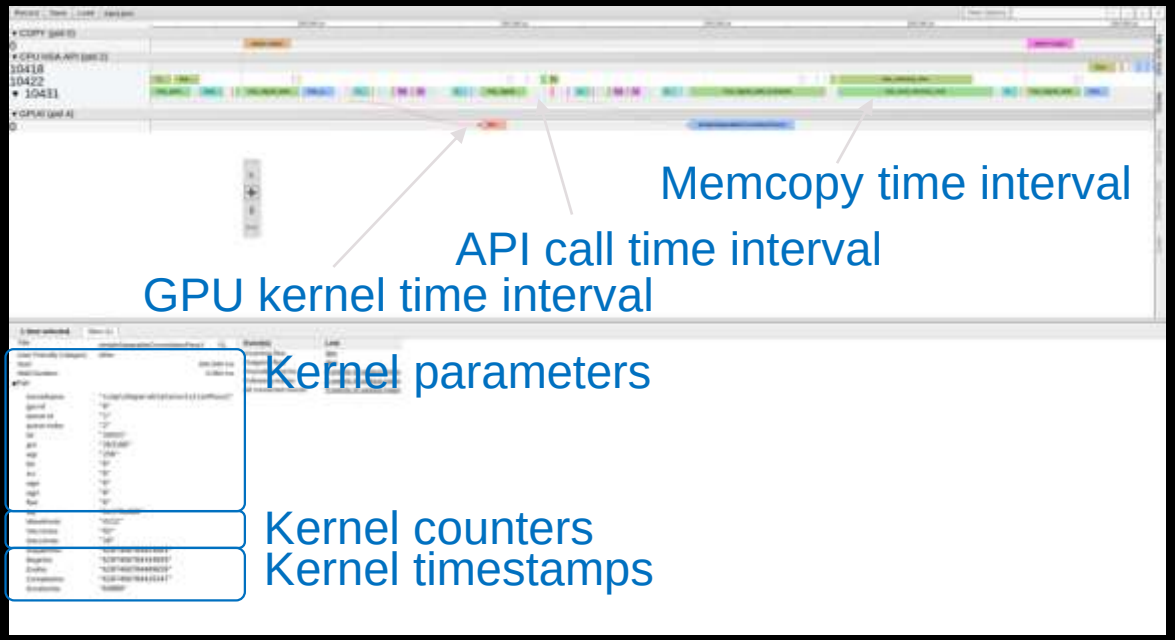
- ROCgdb is the ROCm source-level debugger for Linux
- ROCgdb is based on GDB, the GNU source-level debugger
  - https://github.com/ROCm-Developer-Tools/ROCgdb
- Compile executable using hipcc with “--ggdb"
- ROCgdb location:
  - `/opt/rocm/bin/rocgdb`
- To debug an executable
  - `rocgdb $EXE`
- To attach to a running process
  - `rocgdb -p <pid>`

```
(gdb) where
#0  0x000014825547ce57 in sched_yield () from /lib/x86_64-linux-gnu/libc.so.6
#1  0x00001482771954ad in amd::Event::awaitCompletion() () from /opt/rocm/hip/lib/libamdhip64.so.3
#2  0x00001482770ebc2d in ihipMemcpy(void*, void const*, unsigned long, hipMemcpyKind, amd::HostQueue&, bool) ()
   from /opt/rocm/hip/lib/libamdhip64.so.3
#3  0x00001482770ec127 in hipMemcpy () from /opt/rocm/hip/lib/libamdhip64.so.3
#4  0x0000000000409b08 in HPL_pdlange (GRID=<optimized out>, GRID@entry=0x7ffffcdf8770, NORM=<optimized out>,
    NORM@entry=HPL_NORM_1, M=<optimized out>, M@entry=45000, N=<optimized out>, N@entry=45000, NB=<optimized out>,
    NB@entry=384, A=<optimized out>, LDA=<optimized out>) at ../HPL_pdlange.cpp:302
#5  0x00000000004070ce in HPL_pdtest (TEST=TEST@entry=0x7ffffcdf8700, GRID=GRID@entry=0x7ffffcdf8770,
    ALGO=ALGO@entry=0x7ffffcdf8730, N=45000, NB=384) at ../HPL_pdtest.c:376
#6  0x0000000000402b33 in main (ARGC=<optimized out>, ARGV=<optimized out>) at ../HPL_pddriver.c:227
```

ROC-Profiler / Tracer

Easily Integrated with Industry Standard Tools





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POLYTECHNIQUE MONTRÉAL

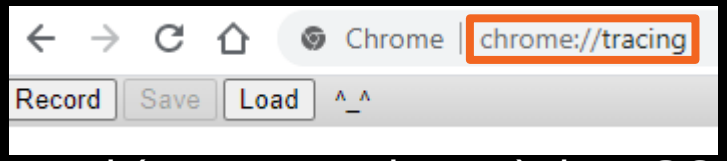
Released Q4-2019

rocprof

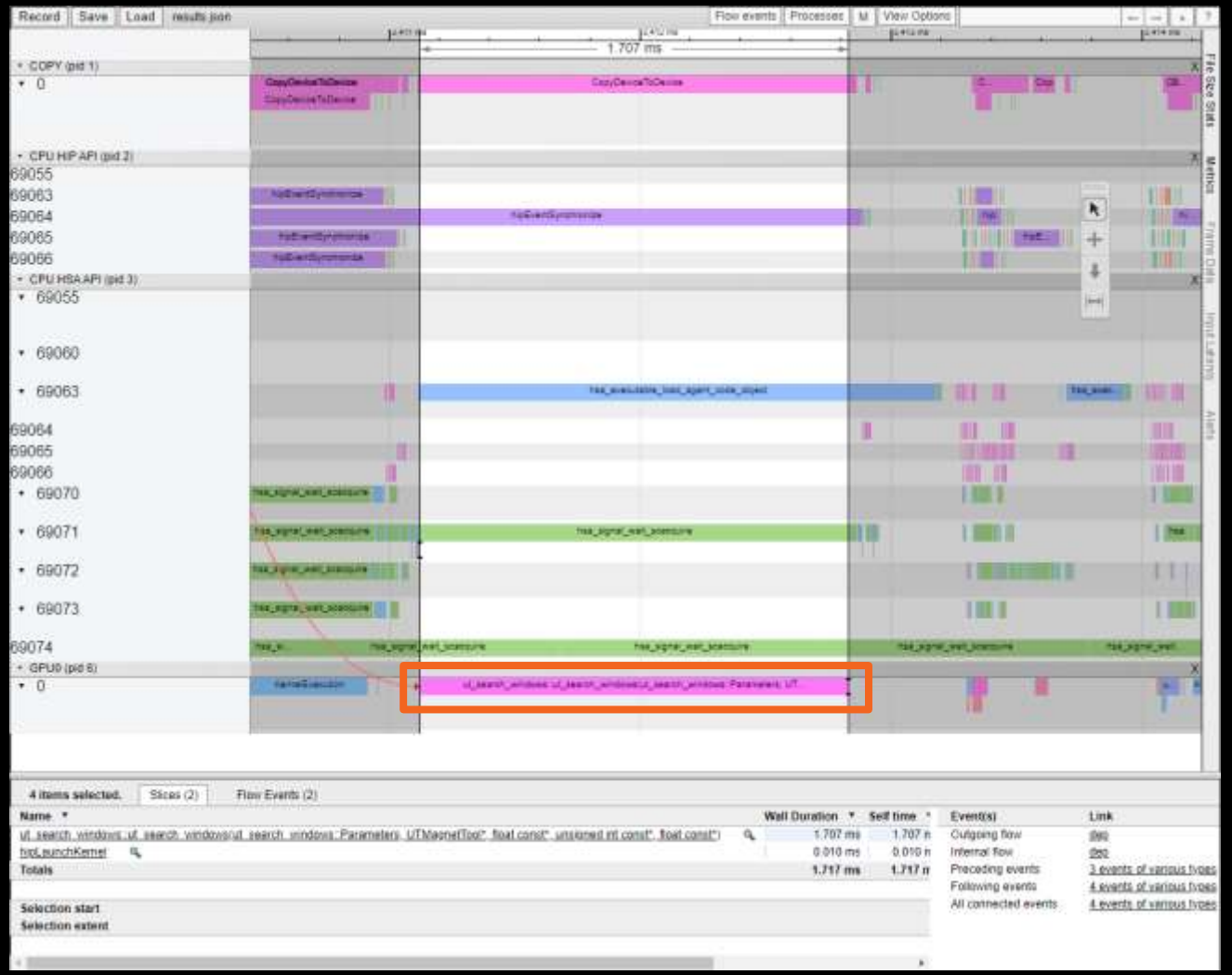
- rocprof is the AMD GPU profiler library
- It profiles with perf-counters and derived metrics
- To run rocprof to generate a kernel profile (text)
  - `rocprof --obj-tracking on --stats $EXE`
  - The default `results.stats.csv` will be generated
  - Comma-separated list of kernel activities

```
"Name","Calls","TotalDurationNs","AverageNs","Percentage"
KernelExecution,1614,473635087,293454,70.2867228678686
"lf_triplet_seeding::lf_triplet_seeding(lf_triplet_seeding::Parameters, LookingF
orward::Constants const*)",27,57000230,2111119,8.458746996112579
"velo_search_by_triplet::velo_search_by_triplet(velo_search_by_triplet::Parameter
rs, VeloGeometry const*)",20,27701080,1385054,4.110797925535989
"velo_calculate_phi_and_sort::velo_calculate_phi_and_sort(velo_calculate_phi_and
_sort::Parameters)",15,11600465,773364,1.721491272443271
```

- Run rocprof to generate a trace file
  - `rocprof --obj-tracking on --sys-trace $EXE`
  - Start Google Chrome
  - Type `chrome://tracing`



- Load (or Drag and Drop) the JSON file to view
- https://github.com/ROCm-Developer-Tools/rocprofiler/




```
--obj-tracking <on|off> - to turn on/off kernels code objects tracking [off]
  To support V3 code object

--stats - generating kernel execution stats, file <output name>.stats.csv

--roctx-trace - to enable rocTX application code annotation trace, "Markers and Ranges" JSON trace section.
--hip-trace - to trace HIP, generates API execution stats and JSON file chrome-tracing compatible
--hsa-trace - to trace HSA, generates API execution stats and JSON file chrome-tracing compatible
--sys-trace - to trace HIP/HSA APIs and GPU activity, generates stats and JSON trace chrome-tracing compatible
  '--hsa-trace' can be used in addition to select activity tracing from HSA (ROCr runtime) level
--kfd-trace - to trace KFD, generates KFD Thunk API execution stats and JSON file chrome-tracing compatible
  Generated files: <output name>.<domain>_stats.txt <output name>.json
```

Visit AMD.com/ROCm

Link to more training information:
https://community.amd.com/community/radeon-instinct-accelerators/blog/

Thank You!

Questions?

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